REMARKS

The above amendments have been made to make minor editorial changes so as to generally improve the form of the claims and abstract.

Attached hereto is a marked-up version of the changes made to the claims and abstract by the current Preliminary Amendment. The attached page is captioned "**Version With Markings to Show Changes Made**".

Respectfully submitted,

Seiji MIZUOKA et al.

By: _____

Nils E. Pedersen
Registration No. 33,145
Attorney for Applicants

NEP/krl
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
June 21, 2001

THE COMMISSIONER IS AUTHORIZED TO CHARGE ANY DEFICIENCY IN THE FEES FOR THIS PAPER TO DEPOSIT ACCOUNT NO. 23-0975

Version with Markings to Show Changes Made

WHAT IS CLAIMED IS:

1. A connection inspecting apparatus for inspecting connection of a connected part, which comprises:

an irradiation part [(111)] for applying a radiation to the connected part of members with an application condition kept invariant;

a scintillator [(115)] for converting a radiation passed through the connected part to a visible light;

an imaging device [(120)] for picking up transmission images of the connected part generated from the scintillator for a plurality of number of times with changing a storage time;

a sub thickness image forming device [(121)] for forming sub thickness images corresponding to the respective plurality of the transmission images of different storage times supplied from the imaging device on the basis of a relationship between a brightness density of the transmission image and a thickness of the connected part; and

a superimposed image forming device [(121)] for forming a thickness superimposed image of the connected part by adding the plurality of the sub thickness images to each other.

2. The connection inspecting apparatus according to claim 1, wherein the superimposed image forming device

computer execute, when the connected parts are present at one and the other face opposite to each other of a plate-shaped member, the process of forming the sub thickness image comprising:

a process of forming first sub thickness images corresponding to the transmission images at the storage times for the connected part present at the one face; and

a process of forming second sub thickness images corresponding to the transmission images of the different storage times in a state where the connected parts are present overlapping at the one and the other face in the application direction of the radiation,

the process of forming the thickness superimposed image comprising:

a process of forming a first thickness superimposed image by adding the plurality of first sub thickness images to each other;

a process of forming a second thickness superimposed image by adding the plurality of second sub thickness images to each other; and

a process of subtracting the first thickness superimposed image from the second thickness superimposed image so as to form the thickness superimposed image of the connected part present at the other face.

14. A connection inspecting apparatus which

comprises:

an irradiation device [(411)] for applying a radiation to a connected part;

a scintillator [(412)] for converting a radiation passed through the connected part to a visible light;

an imaging device [(413)] for picking up a transmission image of the connected part generated from the scintillator; and

an image forming device [(451)] for forming brightness information on the basis of the transmission image supplied from the imaging device of a first connected part [(5011)] and a second connected part [(5012)] of an object [(421, 422)] to be inspected which overlap at a part [(5013)] in a thicknesswise direction thereof, and for forming an image of only the second connected part on the basis of the brightness information.

15. The connection inspecting apparatus according to claim 14, wherein the image forming device binarizes the brightness information so as to form the image of only the second connected part by a bright side level (A+α) brighter than a reference brightness level (A) of the transmission image of the first connected part when the object has only the first connected part and by a dark side level (A-β) darker than the reference brightness level.

16. The connection inspecting apparatus according to

claim 15, wherein, based on an image of the overlapping first connected part and second connected part obtained by binarizing the brightness information, an image of only the first connected part obtained by the binarization by the bright side level, and an image of the overlapping part obtained by the binarization by the dark side level, the image forming device deletes the image of only the first connected part from the image of the first and second connected parts, and adds the image of the overlapping part to an image after the deletion so as to form the image of only the second connected part.

17. The connection inspecting apparatus according to claim 14, wherein the image forming device obtains outline position information of the first connected part based on the transmission image of the first connected part, and forms the image of only the second connected part on the basis of the brightness information and the outline position information.

18. The connection inspecting apparatus according to claim 17, wherein the image forming device detects a brightness change at an outline position indicated by the outline position information with the use of the brightness information, obtains each position information of one position [(516)] and the other position [(517)] in an outline segment of the overlapping part showing a different

brightness change from other positions, obtains information on a divide line [(518)] passing the one position and the other position from the position information, and forms the image of only the second connected part from the brightness information by changing a binarization level at a first region [(519)] including the first connected part and a second region [(520)] including the second connected part which are divided by the divide line.

19. The connection inspecting apparatus according to claim 18, wherein the binarization level formed by the image forming device at the divided first region including the first connected part is a level for extracting only the overlapping part, while the binarization level at the second region including the second connected part is a brightness level of the second connected part obtained when each position information of the one position and the other position is obtained.

20. The connection inspecting apparatus according to claim 18, wherein the image forming device obtains each position information of the one position and the other position on the basis of a peak value of the brightness.

21. The connection inspecting apparatus according to claim 14, wherein the imaging device picks up the image of the first connected part and the second connected part in the overlap state with changing an image storage time.

22. The connection inspecting apparatus according to claim 18, wherein the imaging device picks up the image of the first connected part and the second connected part in the overlap state with changing an image storage time, and the image forming device obtains the one position and the other position in the outline segment of the overlapping part with the use of the brightness information of a largest brightness change among the brightness information of transmission images for every one of different storage times.

23. The connection inspecting apparatus according to claim 22, wherein the image forming device obtains each position information of the one position and the other position on the basis of the brightness information of a largest peak value of the brightness.

24. A connection inspecting method, which comprises:

applying a radiation to an object [(421, 422)] to be inspected which has a first connected part [(5011)] overlapping with a second connected part [(5012)] at a part [(5013)] in a thicknesswise direction of the object, and converting a radiation passed through the object to a visible light;

forming brightness information on the basis of a transmission image of the first connected part and the second connected part in the overlap state which is

obtained through the conversion to the visible light; and

forming an image of only the second connected part on the basis of the brightness information.

25. The connection inspecting method according to claim 24, wherein the operation of forming the image of only the second connected part is carried out by:

binarizing the brightness information so as to obtain an image of the first connected part and the second connected part in the overlap state;

binarizing the brightness information by a bright side level (A+α) brighter than a reference brightness level (A) at a transmission image of the first connected part when the object has only the first connected part so as to obtain an image of only the first connected part;

binarizing the brightness information by a dark side level (A-β) darker than the reference brightness level so as to obtain an image of the overlapping part; and

deleting the image of only the first connected part from the image of the first connected part and the second connected part, and adding the image of the overlapping part to an image after the deletion, whereby the image of the only the second connected part is formed.

26. The connection inspecting method according to claim 24, whereby the operation of forming the image of only the second connected part is carried out by:

obtaining outline position information of the first connected part on the basis of a transmission image of the first connected part with the use of the brightness information;

detecting a brightness change at an outline position indicated by the outline position information;

obtaining each position information of one position (516) and the other position (517) in an outline segment of the overlapping part showing a different brightness change from other positions;

obtaining information on a divide line (518) passing the one position and the other position from the position information; and

binarizing for a first region (519) including the first connected part divided by the divide line by a level in which only the overlapping part is extracted, and binarizing for a second region (520) including the second connected part by a brightness level of the second connected part obtained when each position information of the one position and the other position is obtained, so that the image of only the second connected part is formed from the brightness information.

27. The connection inspecting method according to claim 26, wherein each position information of the one position and the other position is obtained on the basis of

a peak value of the brightness.

28. The connection inspecting method according to claim 24, wherein the first connected part and the second connected part in the overlap state is picked up by changing an image storage time.

29. A computer readable recording medium for recording programs to make a computer execute:

a process of applying a radiation to an object (421, 422) to be inspected which has a first connected part (501) overlapping with a second connected part (5012) at a part (5013) in a thickness direction of the object;

a process of forming brightness information based on a transmission image of the first connected part and the second connected part in the overlap state which is obtained by converting a radiation passed through the object to a visible light; and

a process of forming an image of only the second connected part on the basis of the brightness information.

30. The computer readable recording medium according to claim 29, wherein a program is further recorded for making the computer execute the process of forming the image of only the second connected part which comprises:

a process of binarizing the brightness information so as to obtain an image of the first connected part and the second connected part in the overlap state;

a process of binarizing the brightness information by a bright side level (A+α) brighter than a reference brightness level (A) at a transmission image of the first connected part when the object has only the first connected part so as to obtain an image of only the first connected part;

a process of binarizing the brightness information by a dark side level (A-β) darker than the reference brightness level so as to obtain an image of the overlapping part; and

a process of deleting the image of only the first connected part from the image of the first connected part and second connected part, and adding the image of the overlapping part to an image after the deletion so as to form the image of only the second connected part.

31. The computer readable recording medium according to claim 29, wherein a program is further recorded for making the computer execute the process of forming the image of only the second connected part which comprises:

a process of obtaining outline position information of the first connected part on the basis of the transmission image of the first connected part with the use of the brightness information;

a process of detecting a brightness change in an outline position indicated by the outline position

information;

a process of obtaining each position information of one position [(516)] and the other position [(517)] in an outline segment of the overlapping part showing a different brightness change from other positions;

a process of obtaining information on a divide line [(518)] passing the one position and the other position from the position information;

a process of binarizing for a first region [(519)] including the first connected part divided by the divide line by a level in which only the overlapping part is extracted, and binarizing for a second region [(520)] including the second connected part by a brightness level of the second connected part obtained when each position information of the one position and the other position is obtained, so that the image of only the second connected part is formed from the brightness information.

32. The computer readable recording medium according to claim 29, wherein a program is further recorded for making the computer execute the process of forming the image of only the second connected part which comprises:

a process of obtaining outline position information of the first connected part on the basis of a transmission image of the first connected part with the use of the brightness information;

a process of detecting a brightness peak value in an outline position indicated by the outline position information;

a process of obtaining each position information of one position (516) and the other position (517) of an outline segment of the overlapping part with setting the detected peaks as the one position and the other position;

a process of obtaining information on a divide line (518) passing the one position and the other position from the position information;

a process of binarizing for a first region (519) including the first connected part divided by the divide line by a level in which only the overlapping part is extracted, and binarizing for a second region (520) including the second connected part by a brightness level of the second connected part obtained when each position information of the one position and the other position is obtained, so that the image of only the second connected part is formed from the brightness information.

33. The computer readable recording medium according to claim 29, wherein a program is further recorded for making the computer execute the process of forming brightness information based on the transmission image of the first connected part and the second connected part in the overlap state by picking up the image of the first

Version with Markings to Show Changes Made

ABSTRACT OF THE DISCLOSURE

Brightness information of, e.g., an average value of brightnesses at an X-ray image of a first connected part when an electronic component (422) is mounted onto only one face of a printed board (421) is obtained. Binary images of an X-ray image of the board with the electronic components mounted to both faces are formed by an upper and a lower levels relative to the brightness information. The binary images are synthesized with each other so as to extract an image of only a second connected part. The image of only the second connected part can be obtained in this manner on the basis of the X-ray image of the double face-mounted board, so that an accuracy for connection inspection is improved in comparison with the related art. Also, a relationship between a density in the X-ray image of the connected part and a thickness of the connected part is obtained beforehand, based on which a plurality of thickness images are obtained for a plurality of X-ray images of different image storage times. The connected part can be inspected by synthesizing the images.